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INTERRELATIONS OF INSECTS AND FIRES

SUPPLEMENTARY REPORT

NORTHFORK BURN STUDY

Data for September, 1942

by

John M. Miller
Berkeley, California
February 15, 1943

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Forest Insect Laboratory
Berkeley, California
February 15, 1943

INTERRELATIONS OF INSECTS AND FIRES

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NORTHFORK BURN STUDY

Data for September, 1942

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SUPPLEMENTARY REPORT - NORTHFORK BURN STUDY

I. HISTORICAL

In 1917, the Division of Forest Insects initiated a study of the interrelations of insects and forest fires at the Ashland Field Station in Oregon. During the years following, a series of studies on individual burns was carried on in the ponderosa pine types of Oregon, California and Idaho. As a result of this work, a vast amount of detailed information has been accumulated on bark beetle infestations which followed in the wake of these fires. Listing these studies, we find the following manuscript reports in the files of the Berkeley Laboratory:

Name of Burn	Location	Date	No. of File Reports
Siskiyou	Rogue River Nat. Forest	Sept.,1915	3
Chinquapin	" " " "	Sept.,1915	3
Mistletoe	" " " "	Oct., 1918	3
Snake Lake Burn Experiment	Plumas National Forest	1920-1924	1
Aspen Lake	Klamath Falls, Oregon	June, 1926	1
Parker Mt.	" " "	July, 1924	1
Northfork	Sierra National Forest	June, 1924	2
Sugar Hill	Modoc " "	July, 1929	4
Tubbs Hill	Coeur D'Alene Nat. For.	Sept.,1928	4

During the progress of these studies, one publication was issued, "Preliminary Studies of the Relation of Fire Injury to Bark Beetle Attack in Western Yellow Pine", by J. M. Miller and J. E. Patterson (Journal of Agricultural Research, April 1, 1927).

Investigative work on fire-insect relationships has now been quiescent for a number of years, and the great bulk of accumulated data is still buried in file reports. The project has recently been undertaken of digesting this material for the purpose of summarizing what we have learned and what we still need to know about the interrelations of insects and fires in the pine type

In studies carried on during past years, the chief concern seems to have been with the losses that occurred for the first few years following the fires; i.e., how much of the timber was firekilled and how much was killed by beetles following the fire in different types of burns. Also, much attention was given to the types of fire injury to individual trees which could beconnected with attraction or susceptibility to beetle attack.

These studies did not attempt to follow the long aftermath of beetle infestations in old burns. The changes that take place in the ecology of pine stands over long periods of time after fires and their effect upon insect infestations is a phase upon which further work is needed. Some data is available from the Northfork Burn.

It is the purpose of this report to put on record the recent information secured from the Northfork Burn so that it will be available for the overall survey and review which is being initiated of the fire-insect studies, and to suggest some further field work which can be undertaken to advantage in connection with long term studies in burns of similar character. In presenting this supplementary information, it is advisable first to review briefly the conditions of the Northfork Fire.

The Northfork Fire of 1924.

This burn of 1924 was typical of the severe fires which have swept the pine type of the western slopes of the Sierra Nevada Mountains during dry years. Starting from a burning building at the Forest Service headquarters in Northfork at 11:00 A.M. on June 22, the blaze was soon out of control. Fanned by wind from the west, it spread rapidly to the slopes of Peckinpah Mountain directly to the east and north. There had been little rain since the month of February, and the long, dry spring season had left conditions in the pine type ripe for a conflagration of major proportions. The ground cover was thoroughly dry, and the brush understory on Peckinpah Mountain had not been burned over during the preceeding thirty years.

As a result, the fire made its runs up the slopes of Peckinpah throughout the first day and was not checked until it reached the top of the slopes. It continued to spread to the north during succeeding days and was not brought under final control until June 27.

After the smoke had cleared, and an inventory was started for the purpose of a fire report, it was found that 5,460 acres had been burned over. Much of this acreage had suffered from severe crown fires. Many trees in those crowned areas were unmistakably fire-killed as a result of the burning away of all foliage and buds and the cooking of the cambium on the main bole by intense heat. But by far the greater percentage of the fire-injured trees had only been defoliated or partially defoliated and to all appearances were still alive. Such trees were in areas of the burn where the crown fire had swept through the stand quickly and passed on. While most of the needles had been scorched or burned away, the terminal buds were still green and the cambium living.

The Northfork Burn Study, 1924-1928, Inclusive.

The question that at once came up in appraising the damage caused by this fire was:

How many of the defoliated trees would survive?

If these fire-injured trees, still apparently living, were due to die within the next few years, then the only possibility for realizing on the lumber values that they contained would be through an immediate salvage logging operation. If, on the other hand, these trees stood a good chance of survival and of recovering their normal growth rate, then the stand could be held until the area came within the scope of orderly logging operations.

Equally important questions pertinent to this burn were:

To what extent would bark beetles attack the fire-injured trees and add to the loss caused directly by the fire?

Would conditions resulting from the fire stimulate an increase of bark beetle populations within the burn and adjoining areas?

These are questions that arise in the appraisal of damage for practically all fires in the pine type and are therefore quite general in their implications. Conditions in the Northfork burn offered an opportunity to attack the entomological phases of the aftermath of fires that kill or injure ponderosa pine. The field station of the Bureau of Entomology located at Northfork therefore selected this area with the advice of the Forest Service for one of the study of the basic factors involved in the interrelations of insects and forest fires.

This study was planned and initiated in July, 1924. The follow-up surveys and studies were carried out by Miller and Person during the subsequent period extending up to the close of the 1928 season. Three sample plots of 100 trees each were set up on which all trees were classified as to degree of fire injury and tagged for future records on mortality and recovery. A survey was made of the entire burn in which the area was mapped according to type of burn and an estimate made of the volumes of timber in each class of fire injury. The trees attacked by bark beetles were marked and recorded by a 100% survey of the burn which was made annually throughout the period of the study.

A preliminary report was prepared by Miller in May, 1927, and a final report dated March 28, 1929, brought the results of the study up to the close of the 1928 season. Upon completion of this report, further

further records were discontinued since it was apparent that enough time had elapsed to level off the influences of the fire upon current insect infestations. This assumption was borne out by the discovery that at the end of the 1928 season, most of the trees that had not already died were recovering their crown foliage and that beetle population on the burned area had greatly declined.

II. SUMMARY OF PREVIOUS REPORTS

The two reports that have already been presented show that the following developments took place in the burn during the period from 1924-28, inclusive.

1. Acreage by Types of Burn.

	No. of Acres
a. Light burn (mostly ground fire) - no trees fire-killed - light to moderate scorching of foliage on lower limbs	3,790
b. Medium burn (light crown fire) - less than 25% of trees fire-killed - 50% or more of trees severely scorched	1,300
c. Heavy burn (severe crown fire) - more than 50% of trees fire-killed or completely defoliated	370
Total Acreage	5,460

2. Percent of Trees and Volume by Fire Injury to Crowns.

Class	% of total stand by trees	% of total stand by volume
I. No visible fire injury	14.1%	17.2%
II. Less than 25% of crown defoliated	28.3	44.3
III. From 25% to 50%	16.0	15.6
IV. From 50% to 75%	17.1	14.6
V. From 75% to 100%	14.5	5.1
VI. 100% of crown defoliated, terminal buds killed, cambium scorched, (fire-killed)	10.0	3.2
Total	100.0%	100.0%

3. Percent of Mortality by Fire and Insects.

	Percent of total stand by volume
Killed by the fire	3.2%
Killed by insects, mainly bark beetles	24.8
Surviving to October, 1928	72.0
Total	100.0%

4. General Developments Following the Fire.

1924 In addition to trees killed by the fire in June, 3.5% of the stand was killed during the latter part of the season, mainly as a result of bark beetle attack on injured trees of Classes IV and V.

1925 Practically all trees surviving until the spring of this season put out new needle-growth regardless of the degree of defoliation. Bark beetle concentrated in the burn and during the course of the summer attacked and killed a high percent of the trees in Classes IV and V. The loss for this season totaled 3,698,000 f.b.m., or about 20% of the surviving volume on the burn. This was the peak year of beetle activity - 79% of the total losses in the burn for the period 1926 - 1928, inclusive, occurred during 1925.

1926 This season marked a great decline in the bark beetle activity within the burn. The volume of timber killed (about 2.6% of the remaining stand) was less than that for 1924. The bark beetle attacks for this season predominated in surviving trees of Class III.

1927 and 1928 Bark beetle infestations during these two seasons was endemic within the burn, and losses were lighter than before the fire. Such trees as were attacked were largely in Classes III and IV. The more severely defoliated trees still surviving in October, 1928, were slowly recovering their normal amount of foliage and growth rate.

5. Further Developments Since 1928.

Although continuous records were not maintained, conditions within the burn were under observation from 1928 to the close of the 1942 season. Climatic influences during this period were marked by a series of dry seasons from 1929 to 1933. Around the burn bark beetle infestations became agressive in 1930, and spectacular epidemics prevailed through a large part of the lower ponderosa pine belt of the Sierras until 1934. In the Cascadel check area adjoining the Northfork burn approximately 35% of the pine stand was killed by beetles during this period.

The entire area of the burn has escaped any further fires since 1924. The only man-made factors have been the cutting of occasional beetle-infested trees during the period of the epidemics and the clearing of fire breaks and rights-of-way by CCC projects. These latter have disturbed conditions slightly within the burn.

In 1942, it was noted that some of the surviving trees on the sample plots were those which, according to the records, had been heavily defoliated at the time of the fire. These trees are now vigorous and making excellent growth. The ground cover has also undergone material changes from the conditions described in the previous reports. To bring this information up to date, Miller and Struble rechecked two of the plots in September, 1942, took cores from surviving trees and felled two trees for a complete analysis of the growth picture.

III. DATA SECURED DURING SEPTEMBER, 1942

1. Conditions on the Burn as a Whole.

Eighteen seasons have passed since the fire, and there is as yet little evidence that much of the burned over area is restocking with enough new growth to replace the pine stand that was destroyed. (See figures 1 and 2) The period of dry seasons which followed the fire may have had much to do with discouraging regeneration of the pine type. Much of this area is marginal site for ponderosa pine, and it may require a series of highly favorable precipitation periods to establish pine reproduction on the exposed slopes. The worst scars are now covered with grass or heavy brush.

On the whole, it seems that the scar of the Northfork burn will continue on the slopes of Peckinpah Mountain for many years to come. In this respect, the trend for this area seems to be a phase of the recession of pine type which has occurred in many places on the western slopes of the Sierras as a result of repeated fires, bark beetle epidemics, and severe drought periods. Except for the more favored sites where ground moisture is available, the lower pine belt has been pushed back to higher elevations where there is abundant precipitation and where the topography gives some protection from the fires sweeping in from the grass and brush areas of the lower foothills.

2. Conditions on the Sample Plots in 1942.

The examination in 1942 was confined to rechecking two of the sample plots on which the trees were tagged and continuous records were kept up until October 1928. The original plots established in 1924 were the following:

Plot I. Heavy burn (Inspector Trail)	100 trees
Plot II. Light burn (Pine Flat)	100 "
Plot III. Medium burn (Granite Grade)	100 "

At the time these Plots were established in 1924, Dr. Craighead called attention to the desirability of identifying the 1924 ring in each tree from which future growth records were to be taken. Accordingly, a light cambium scar was made on each tree at the time it was tagged, and this identification scar has been of considerable value in orienting the growth rings for the years both preceeding and after the fire.

Plots I and II were both rechecked for all surviving trees. Plot III was not rechecked since the original records were not satisfactory in showing representative trends within the burn. The plot was established on a site where there was considerable fir in mixture with the pine, and there was also a wide spread in the degree of fire injury affecting the pine.

a. Plot I

This plot was established near the top of a steep westerly slope. The trees that were marked for records composed a middle-aged stand of ponderosa pine with a moderate understory of brush (see figures 2 and 3). The fire coming up the slope had developed intense heat when it reached the plot area and defoliated all trees, producing the severe crown type of burn.

Since the fire, a heavy brush cover of ceanothus and manzanita has become established over the entire plot. This is shown in figure 5. The brush now has reached a height of from 4 to 6 feet and is so dense in most places that it is quite difficult to get around over the plot for observations. Except for four survivors, the trees originally tagged are now down, snags hidden in the brush cover. Pine reproduction is absent except for a very few small trees that have not yet gotten above the brush cover.

Inventory of Plot I, September 20, 1942

Class	Number of Trees		
	Original Inventory	Surviving Oct., 1928	Surviving Sept., 1942
III. 25 to 50 % defoliated	1	0	0
IV. 50 to 75% "	21	6	4
V. 75 to 100% "	72	1	0
VI. Fire-killed	6	0	0
Total	100	7	4

b. Plot II

The site of this plot is on a gentle northerly slope. When the plot was established, the pine stand was of mixed ages, containing a number of large mature trees and a few groups of young trees in the small pole sizes. The ground was practically clear of brush, the cover being mainly grass and bear clover. The type of burn was classed as a light ground fire. All of the trees over 20 inches, D.B.H., escaped serious fire injury and were in classes I to III. In the small pole groups, the fire crowned sufficiently to cause defoliation which accounts for 19 trees on the plot in Classes IV and V. There were no trees killed by the fire.

In rechecking the plot in September, 1942, it was found that the Ponderosa Way Fire Line, constructed in 1933, had passed through one part of the plot and that a number of the tagged trees had been cut in clearing the fire break. These missing trees interrupted the growth record for the plot as a whole, but enough surviving trees were found to make up a fair cross section of the ring picture in the different classes of fire-injured trees.

Inventory of Plot II, September, 1942.

Class	Number of Trees			
	Original Inventory	Surviving Oct., 1928	Surviving Sept., 1942	Missing Sept., 1942
I. No fire injury	21	21	5	16
II. Up to 25% defoliated	42	42	21	21
III. 25 to 50% "	19	17	12	5
IV. 50 to 75% "	11	10	8	2
V. 75 to 100% "	7	6	6	0
Totals	100	96	52	44

Cores were taken from all of the 52 surviving trees found on this plot in September, 1942. The measurements of these were used as a basis for a comparison of the average growth rate in each of the five classes of fire injury represented on this plot.

IV. EFFECTS OF CROWN DEFOLIATION BY FIRE UPON GROWTH RATE

The final report of March, 1928, included the following statements on this point:

> "In the preliminary report (May, 1927), considerable attention was given to growth conditions in trees surviving the fire. It was shown that many trees in Classes IV and V on both the sample plots and strips had failed to make any appreciable growth up to the close of the 1926 season. In certain trees on the sample plots, evidence of annual rings (following 1924) were lacking entirely except around the healing scars where the trees were blazed when they were tagged."

General conclusions relating to the effects of fire injury on growth rate which seem to be warranted by the evidence in the two reports on the Northfork Burn, can be summarized as follows:

1. Classes I and II show little, if any, suppression of growth which can be attributed to fire injury. On the average, the growth made in 1925 was distinctly better than in 1924.

2. Class III shows some suppression of growth in 1925 and 1926, but on the average, the 1925 growth was slightly better than 1924. During 1927 and 1928, trees in this class had apparently recovered their pre-fire growth vigor.

3. Classes IV and V show greatly suppressed growth following the fire. The 1925 ring averages are very much lower than 1924. Many trees in these two classes made no appreciable growth for several years following the fire.

These conclusions are supported by the growth data secured in 1942 covering a longer period after the fire. The average growth rate for the period from 1920 to 1930, inclusive, from trees still surviving in each class of fire injury on Plot II is shown by graph in Figure 8.

This graph indicates a direct correlation between the degree of fire injury, as represented by Classes I to V, and suppression of growth immediately following the fire. This correlation extends over a period of four seasons; however, during the fifth and sixth seasons after the fire (1929 and 1930), there was a general leveling off of growth differences between classes with the exception of Class V which still seemed to be lagging behind the others.

In Figure 7 are photographs of cores from 5 surviving trees selected to illustrate the extremes in growth behavior. In this group the Class IV and Class V trees show continued suppression of growth after the fire, extending up to the 1935 and 1936 seasons where recovery can be recognized.

V. RELATION OF BARK BEETLE ATTACK TO FIRE INJURY CLASSES

It has long been established that trees of slow growth, especially those that have suffered a recent set-back in growth rate, are highly susceptible to bark beetle attack. This has been found to be the case where other causes than fire injury, such as drought, loss of root system, and diseases bring about a suppression of growth. Years of study of the entomological problems concerned with ponderosa pine stands in Oregon and California have lead to the conclusion that failure of the tree to grow normally is in some way connected with lack of resistance to attack by the Western pine beetle and other cambium feeding insects.

However, when it comes to establishing a direct correlation between the suppressed growth of fire-injured trees on the Northfork burn, and subsequent bark beetle attack, the relationship is notso obvious. Some degree of correlation does exist, but it is not as positive as that between fire injury and suppressed tree growth. Other factors have apparently modified the attraction of the beetles to suppressed trees in the burn, and this may account for the departure from the expected correlation curve.

In the 1929 report on this burn, no attempt was made to graph beetle attack with fire injury classes, but a comparison of the four trees attacked in 1928 with the six surviving trees on Plot I is presented on Page 23 of the report. This shows the living trees making rapid growth recovery since 1925, while the beetle-attacked trees had made no perceptible recovery up to the time they were killed.

Such correlation as does exist is brought out by a comparison of the mortality percentages in each class of fire injury presented in table form on Page 6 of the 1929 report.

Class	Percent of Class Killed (By Volume)
I	.9%
II	7.0
III	51.6
IV	76.9
V	44.2

The mortality trend is consistent up to Class V which suddenly drops well below that of Class IV. This was explained in the report by the fact that the small pole-sized trees which made up the bulk of Class V on this burn were below the ages usually selected for attack by the western pine beetle. Most of the trees over 18 inches, D.B.H., in this class were attacked and killed - it was the young trees that survived.

There are still 18 surviving trees on Plots I and II which, according to records, were originally placed in the fire injury Classes IV and V. All of these trees now have vigorous crowns and are growing rapidly. But both the original records and the cores taken from these trees show that they lost most of their foliage during the fire and suffered a severe setback in growth rate for several years following. On the basis of growth rate during the period of suppression, these trees would have been considered "high risk"; yet they passed through the period after the fire when barkbeetles were active in the burn without being attacked. They also survived the period of dry seasons from 1919 to 1933 and the bark beetle epidemics that followed the drought.

Why did these trees escape when hundreds of others in the same classes of fire injury and growth suppressions were attacked?

One explanation that might be advanced for their immunity is that there is a possibility that trees making little growth at the base may be making good growth at the top. All we know about the ring growth in the trees included in these studies is from the basal cores taken at breast height. Such cores may not truly represent the type of growth that is formed higher up the bole.

It was to throw some light on the character of growth in the tops of fire-injured trees that trees 89 and 182 were felled and sectioned for a study of the growth pattern throughout the height of the tree. The results of this study are shown in Figures 9, 10, 11 and 12 with the accompanying explanations of the figures. From these two trees it cannot be established that there is any significant difference in the growth behavior between the base and the top that will account for their survival over similar trees that were attacked and killed by beetles.

Obviously, the western pine beetle does not always behave consistently and do what we expect it to do. Other factors than growth rate may influence its selection of trees. One factor that cannot be dismissed is the abundance or lack of beetles in the vicinity of susceptible trees. Where there are more growth-suppressed trees than beetles to attack them, chance selection must play an important role so that some trees escape as these 18 survivors on the plots have done.

VI. EFFECT OF CAMBIUM INJURY ON GROWTH RATE AND INSECT ATTACK

In the original records on this burn, some attention was given cambium injury. When the identification scar was made at the time the trees were tagged, the condition of the exposed cambium was noted. Where cambium injury caused by the fire was detected, the presence of insect attack in vicinity of the scars was noted in subsequent examinations. While it was noted that flathead borers often attacked around the edge of exposed catface scars, these records were on the whole unsatisfactory in revealing any relation between cambium injury and bark beetle attack.

It is altogether possible that a considerable amount of cambium injury was overlooked in this study since the general run of basal injuries in this fire did not burn the bark sufficiently to expose the cambium. At the same time, some cambium may have been sufficiently overheated to cause a scar under the bark, but the detection of any number of such scars was largely a matter of chance.

The presence of one of these concealed scars is brought out by Figure 13 which shows the north quadrant from the breast height section of tree 89. Here a cambium scar under the bark was not noted when the tree was first examined in 1924. By 1933 the scar had been completely covered by wood rings. Figure 14 shows that in the section immediately above this scar, the growth rings had not been affected by the injury.

VII. SUGGESTIONS FOR FURTHER STUDIES

This study of the Northfork burn has carried developments through the critical years following the fire, and from the summary of available records, we have been able to establish a relationship between crown fire injury and subsequent susceptibility to bark beetle attack. The conclusions presented in this and preceeding reports are supported by studies of other burns in the ponderosa pine types of the region. It is believed that little new information can be gained by attempting to accumulate further data on the susceptibility of fire-injured trees on the basis of crown ratings.

However, the ecology of pine beetle infestations in pine stands which have survived fire over a long period of years is a field in which very little has been done. Studies along this line can be developed profitably, and it is suggested that some of the older burns in the pine type of the California region be examined to show what information they may

yield on the susceptibility of surviving pine stands to beetle attack after the immediate conditions produced by the fire have leveled off. While original records of conditions in the stand and current bark beetle infestations at the time of the fire are lacking, a considerable amount of information may be obtained from the following sources:

1. Forest Service Fire Reports and history of the burn.

2. Plot inventories of present cover and stand conditions.

3. Behavior of recent infestations in and around the burns.

4. Resistance of surviving trees as indicated by recent growth conditions in these trees.

Among burns which can be suggested as satisfactory for such a study because of the time that has elapsed since the fire are the Toll House and Harris Ranch Burns on the Sierra, the Verdi Burn on the Mono, and the Anderson Valley Burn on the Stanislaus. The latter should be a profitable burn to study since the Berkeley Laboratory maintained a 320-acre sample plot for several years at Anderson Valley prior to the fire, and these records are available.

VIII. PHOTOGRAPHS AND GRAPHS

Figure 1

September, 1925. Scar of Northfork Burn one year after fire.

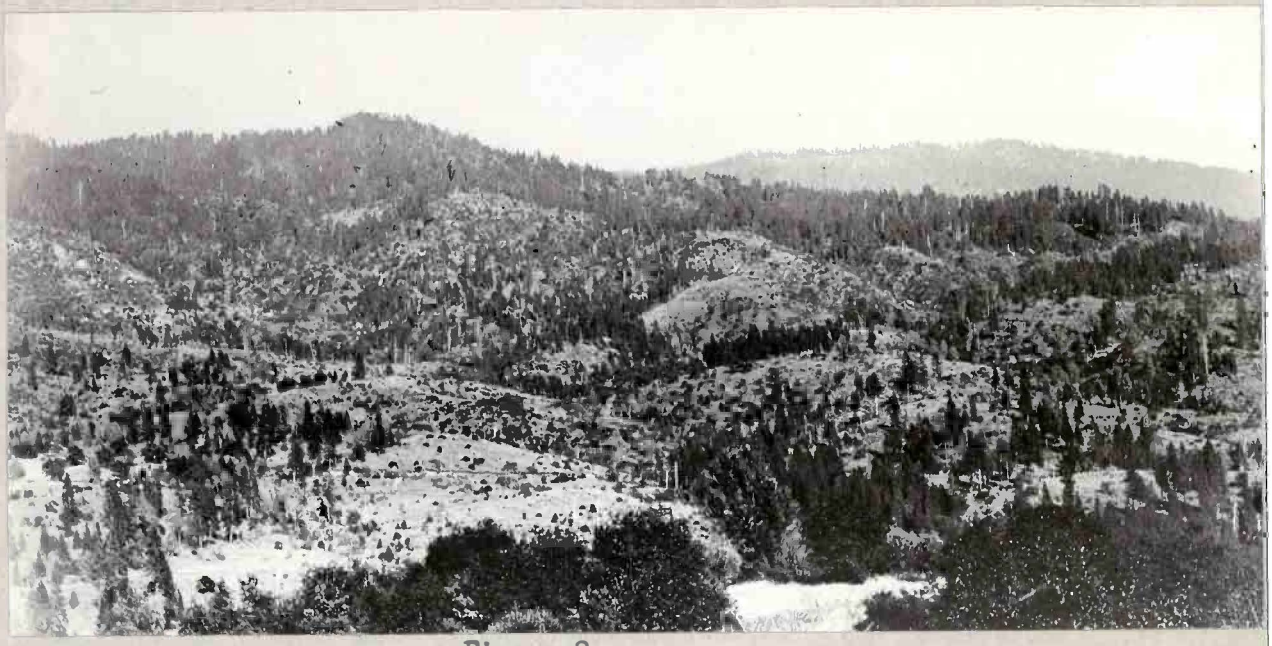


Figure 2

September, 1942. Scar of Northfork Burn eighteen years after fire.

These two pictures were taken from the same point on Shinn Ridge looking east toward the slopes of Peckinpah Mountain. On June 22, 1924, the fire burned over the immediate foreground and swept practically all of the first slopes in these pictures.

The upper photo taken 14 months later shows the fire-killed areas and the pine stands which survived the fire. The light colored trees are those with fading and sorrel foliage resulting from attack by bark beetles.

The lower picture shows the changes during a seventeen-year time interval. Much of the surviving stand of pine has been depleted. The bare slopes have so far restocked mainly to brush and grass cover. Brush has grown up to obscure the immediate foreground.

FIRE-INJURED TREES WHICH SURVIVED CROWN FIRE ON PLOT I, NORTHFORK BURN

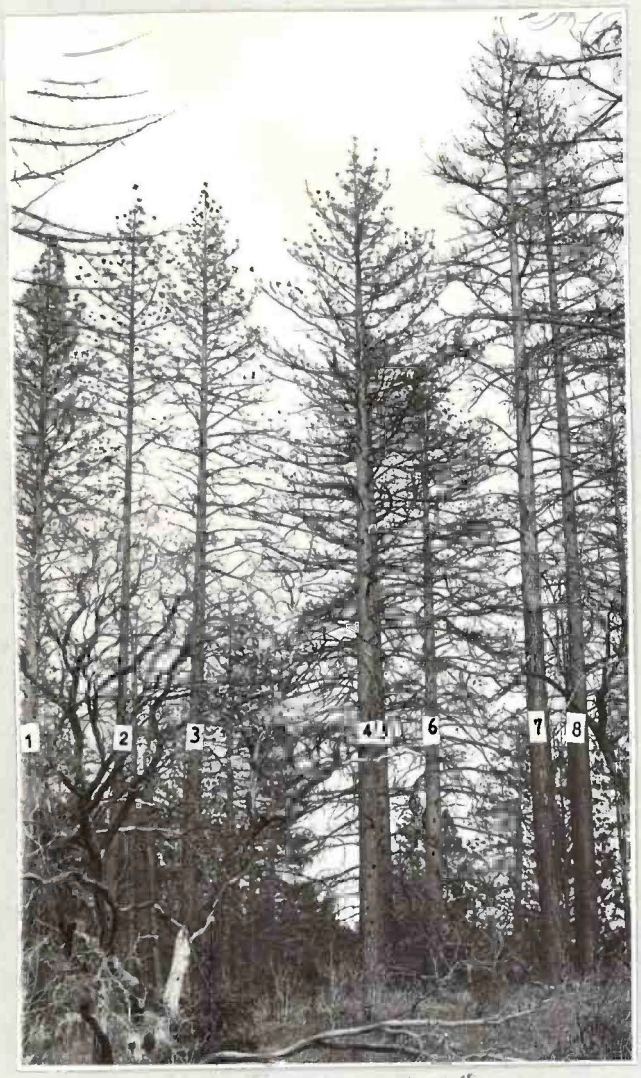


Figure 3 6174

Fig. 3 (left), May, 1925

The trees identified by Nos. 1-8 were all heavily defoliated by fire. No. 1 was given a Class IV rating. The others were all classified as V. When these trees were examined in July, 1924, practically all needles had been burned away, but the buds formed in the spring of 1924 were still alive in the tops.

When this picture was taken in late May, 1925, these buds had opened and formed new needle tufts which show on the ends of the twigs giving the trees their thin-crowned appearance.

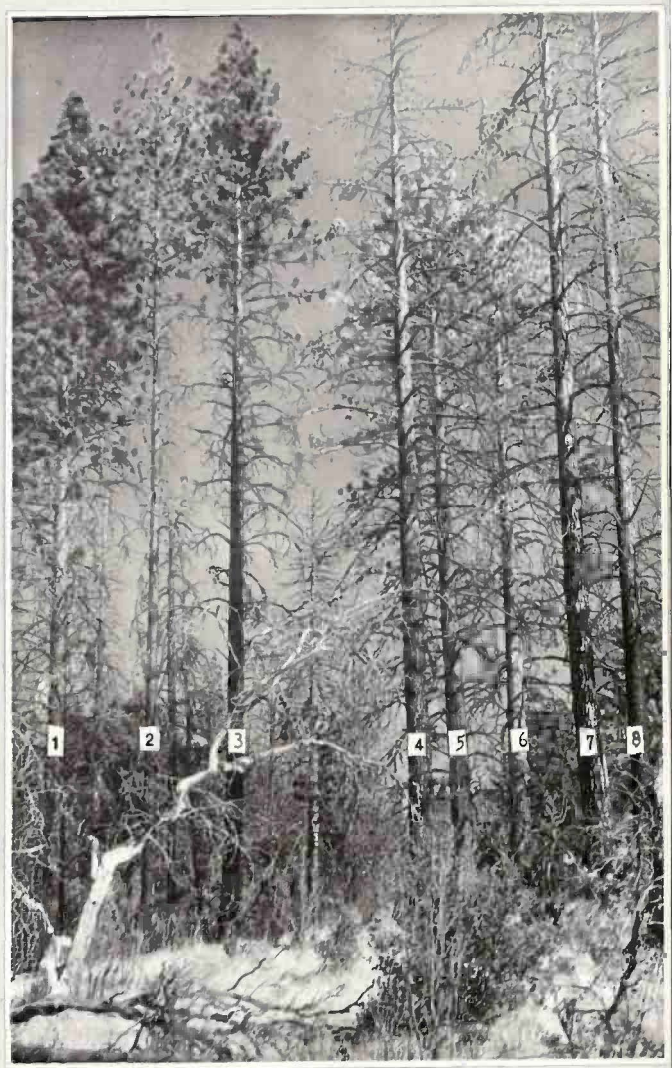


Figure 4
6675

Fig. 4 (right), October, 1928

From a slightly different angle this picture shows the same trees as those shown in Fig. 3, three seasons later.

Trees No. 4, 7 and 8 were attacked by bark beetles during the summer of 1926, and on the date when this picture was taken, all foliage had fallen.

Trees No. 2, 5 and 6 had recovered a large part of their crown foliage at the time when they were attacked by beetles during the summer of 1928. In October they still retained their fading and sorrel foliage which registered in this photo.

Records subsequent to these photos show that tree No. 3 was killed some time after 1928. Tree No. 1 was still surviving in 1942. All other trees have fallen and heavy brush has captured theground cover.

SURVIVING TREES ON PLOTS I AND II OF NORTHFORK BURN
EIGHTEEN YEARS AFTER FIRE

Figure 5

PLOT I (left)

These two trees are remnants of a stand of pine similar to that shown in Figures 3 and 4.

The brush cover of ceanothus and manzanita now grown higher than a man's head, shows in the lower part of this photo.

The tree on the far left is No. 89 which was cut in September, 1942, and sectioned for an analysis of growth throughout the length of the main bole.

PLOT II (right)

The open ground cover on the plot is shown by this picture. In the back ground is the opening made by the clearing of the Ponderosa Way fire break which was cut through the plot in 1933.

The dominant tree in the center is No. 184 which was defoliated by the fire and was given a Class V fire injury rating in 1924. The small tree just behind and to the right of 184 is No. 182 which was felled and sectioned in September, 1942, for growth analysis.

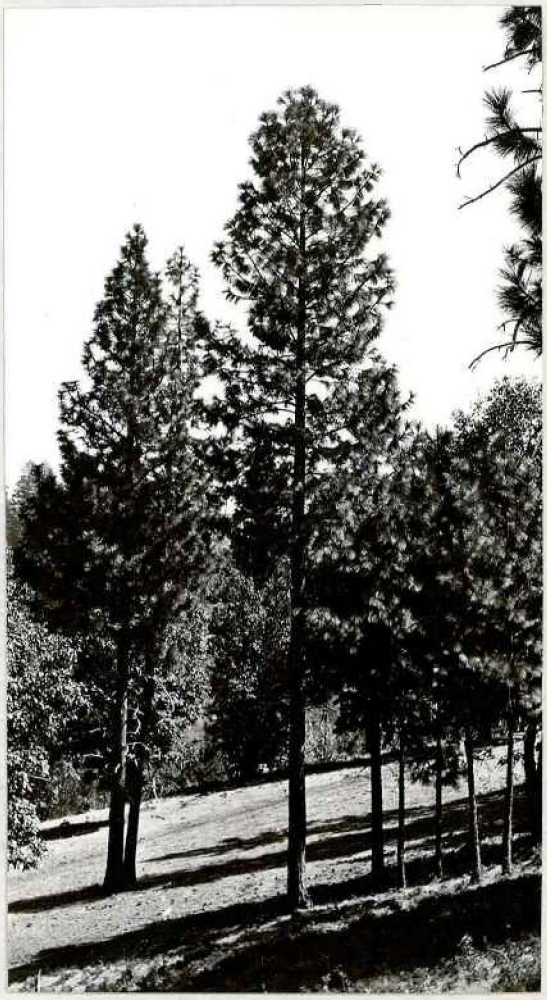
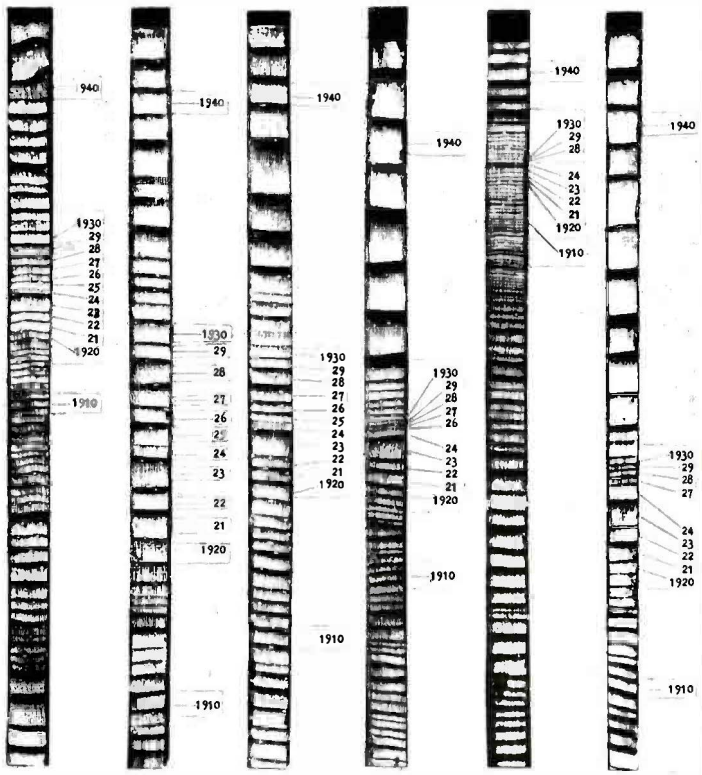


Figure 6

COMPARISON OF CORES FROM SIX SURVIVING TREES ON PLOT II, NORTH FORK BURN

SHOWING GROWTH BEFORE AND AFTER FIRE OF JUNE 22 - 27, 1924, IN TREES OF DIFFERENT CLASSES OF FIRE INJURY. CORES WERE TAKEN SEPTEMBER 16, 1942



Tree No.	115	153	135	162	144	182
D.B.H.	24"	30"	28"	24"	14"	12"
Injury Class	I	I	III	IV	V	V
% defoliation	0	0	40%	75%	100%	90%
Rings missing	0	0	0	1925	1925 1926 1927	1925 1926

Figure 7

Above are pictures of basal cores which were selected to show growth behavior before and after the fire in representative trees from different classes of fire injury. These were all photographed to the same scale. All trees show great release of growth in recent years as a result of stand thinning and favorable precipitation years.

No. 115 and 153 suffered no fire injury and show no effects of the fire.

No. 135, Class III, did not lose any rings but shows a slight suppression of growth in the 1925 and 1926 rings.

No. 162, Class IV, shows definite suppression of growth since the fire. The 1925 ring is missing, and the tree did not recover its former growth rate until 1935.

No. 144, Class V, was a very slow growing, pole-sized, suppressed tree at the time of the fire. The first ring formed after the fire in 1928. Release did not take place until 1936.

No. 182, Class V, was a fast growing pole-sized tree. The first ring formed after the fire in 1927. It did not resume its former vigorous growth rate until 1931.

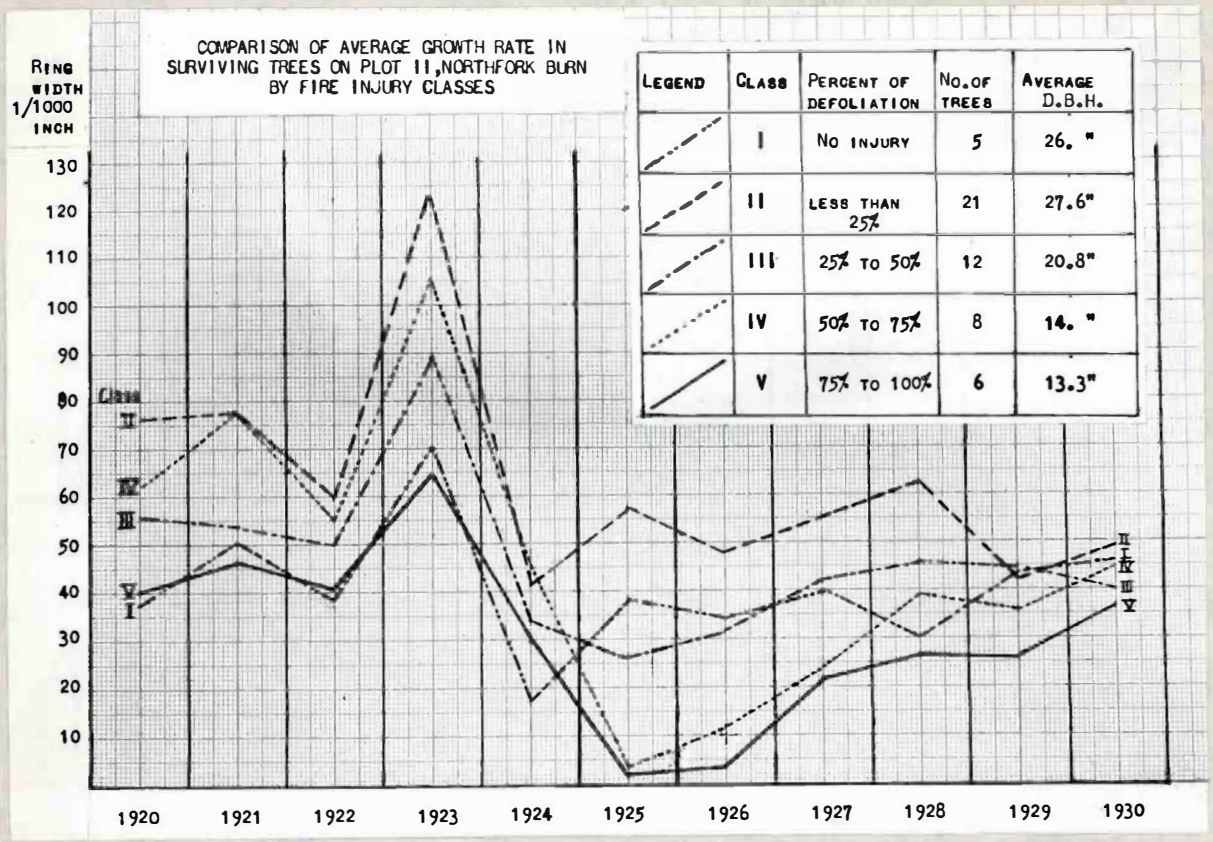


Figure 8

Growth measurements of basal cores from the 52 trees found surviving on Plot II in September 1942 were averaged according to class of fire injury. The above graph shows a direct correlation between growth formed after the fire and the class of fire injury.

The groups of trees in Classes I and V were both growing at about the same average rate before the fire. The season of 1925, the first year following the fire, was a distinctly better year of growth for the trees in Class I than 1924. In Class V, however, the average growth rate for 1925 and for the years immediately following was very low. By 1930 the growth rate of the Class V trees had not yet caught up with Class I.

Class II, which suffered only slight defoliation by the fire, shows the same recovery of growth in 1925 as Class I. Class III, which was defoliated up to 50%, shows some effect of the fire and the growth in 1925 dropped below that of 1924 but not nearly to the extent of that in Classes IV and V.

SECTIONS FROM SW EXPOSURES OF TREES 89 AND 182
SHOWING IDENTIFICATION RINGS USED IN ORIENTING
GROWTH BEFORE AND AFTER FIRE OF JUNE, 1924

TREE 89
PLOT I

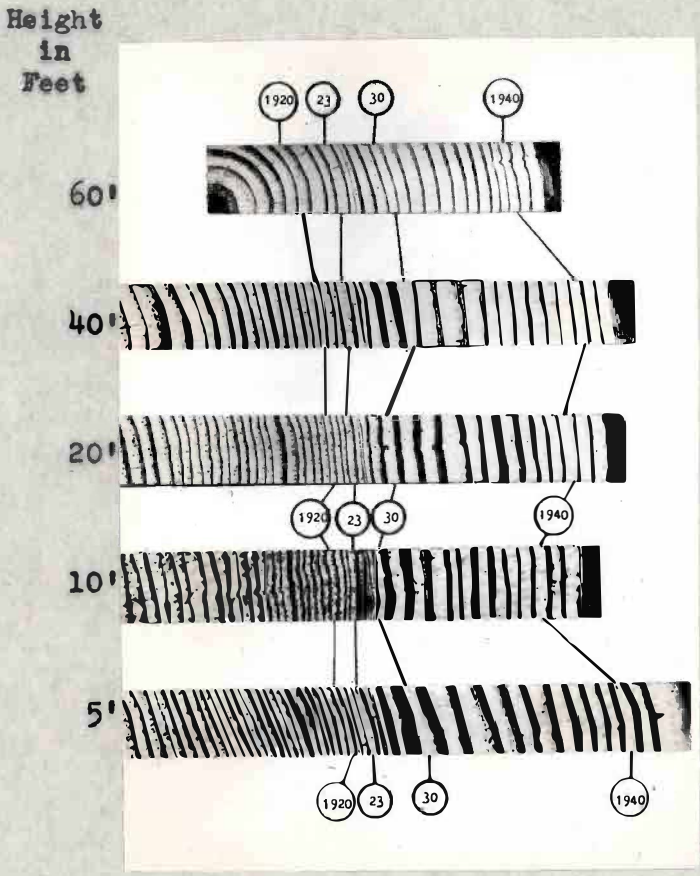


Figure 9

TREE 182
PLOT II

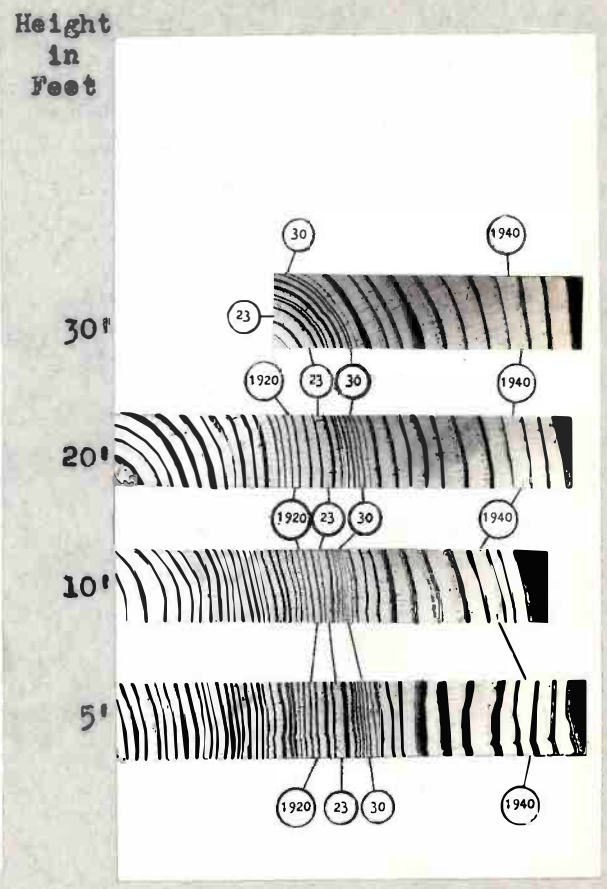


Figure 10

Throughout the westside ponderosa pine type the 1923 growth ring is characterized by wide spring wood and a heavy band of summer wood. The 1924 ring following is characterized by a narrower band of spring wood and a very faint band of summer wood. These two rings, as well as the identification scar which was made on the phloem of the 1924 growth when the plots were established, were used in identifying the growth rings immediately following the fire.

The 1940 and 1930 rings were located by counting back from the 1942 growth which was completely formed when these sections were taken in September, 1942; the 1920 ring was located by counting back from 1923. For the detail of rings in each of these trees, see Figures 11 and 12.

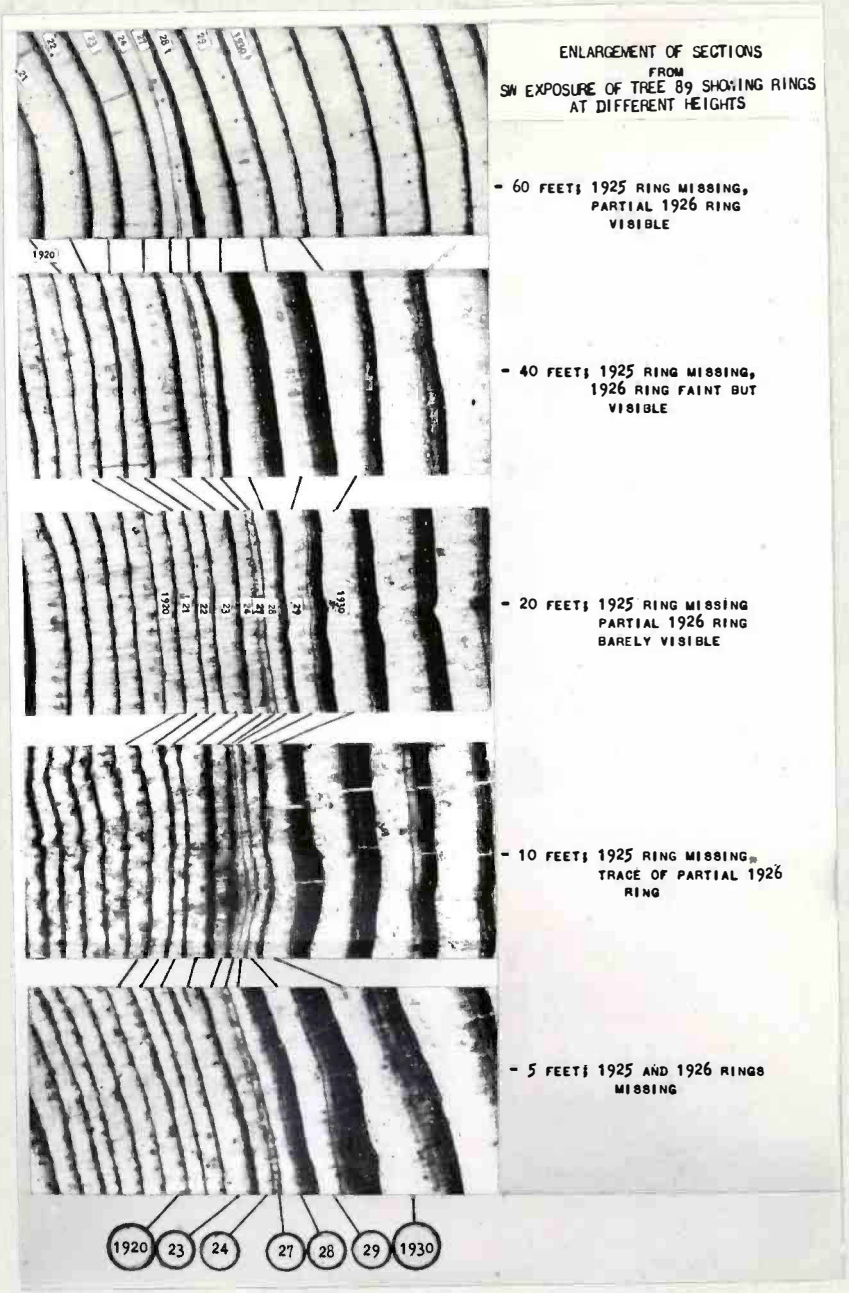


Figure 11

The above sections correspond to cores 3/4 of an inch thick, enlarged about twice to show detail of the rings.

At the time of the fire, tree 89 was a Keen Class IIb, 22", D.B.H., making fairly good growth. The amount of defoliation was between 50% and 75% with green needle tufts in the top, and the tree was classified as fire injury IV.

While both the 1925 and 1926 rings are missing in the basal section at the 5-foot height, a faint partial 1926 ring, beginning at 10 feet, was formed throughout the length of the bole. Recovery of growth started in 1927. The effect of release stimulated a growth rate more vigorous than that preceeding the fire.

A section taken at the 70-foot height was above the 1924-26 rings and therefore did not show the immediate effects of the fire.

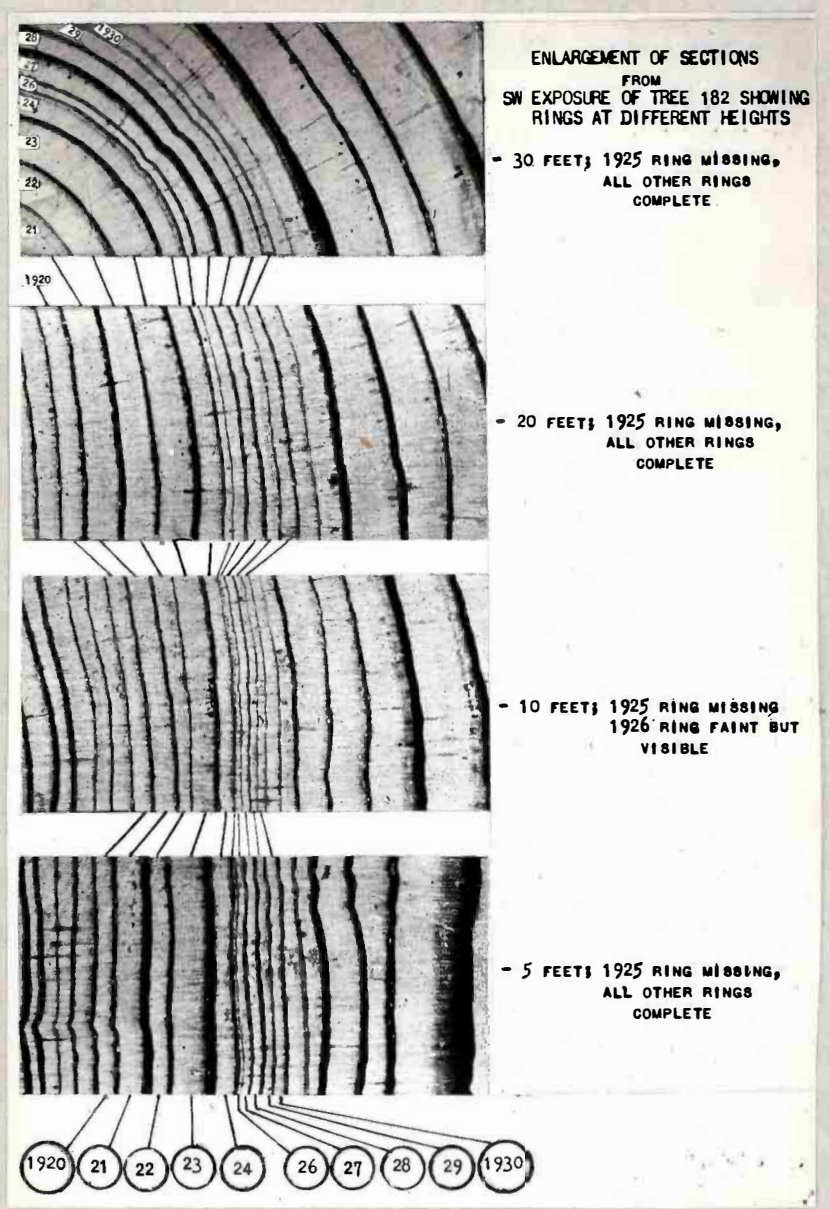


Figure 12

Tree No. 182 was a dominant in a group of small pole-sized trees. It was in the Keen age class Ib or Ic, 8", D.B.H., and had been making good growth prior to the fire. More than 75% of the foliage was burned away, but a few green needle tufts survived at the extreme top. It was classified as fire injury V.

The 1925 ring is missing throughout the bole. The 1926 ring is present at all heights although it is very faint in the section at 10 feet.

It is apparent that the growth, both in this tree and in tree No. 89, shows no significant differences in behavior between the base and top of the bole.

Figure 13

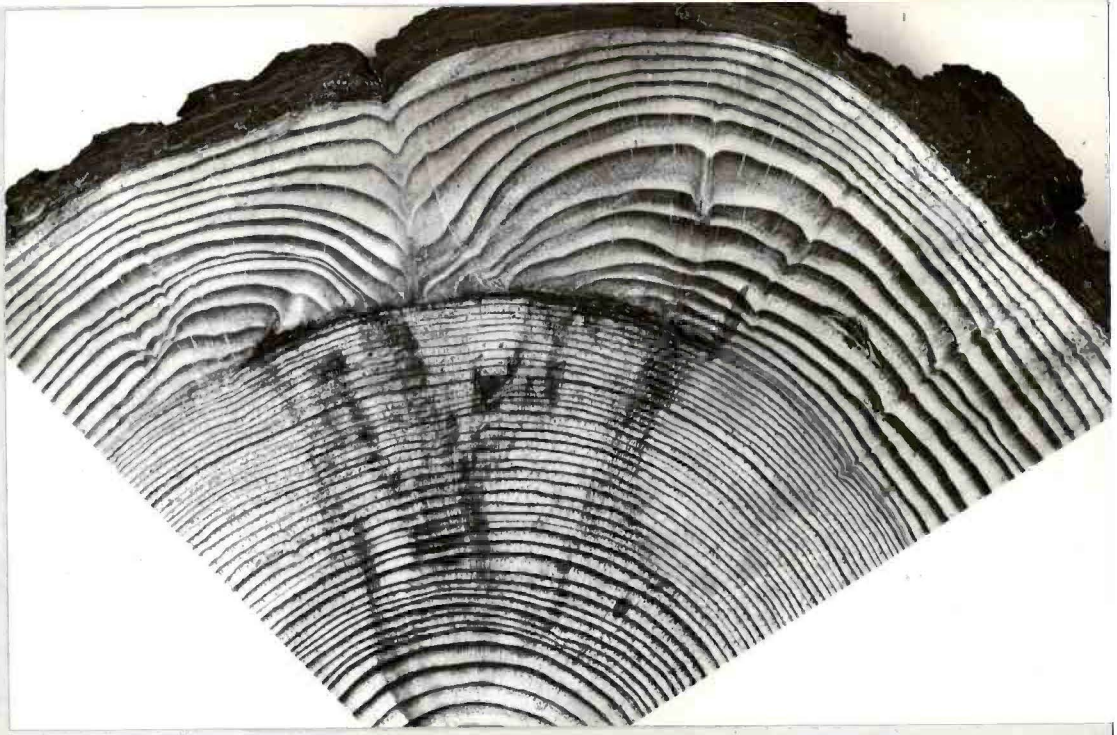
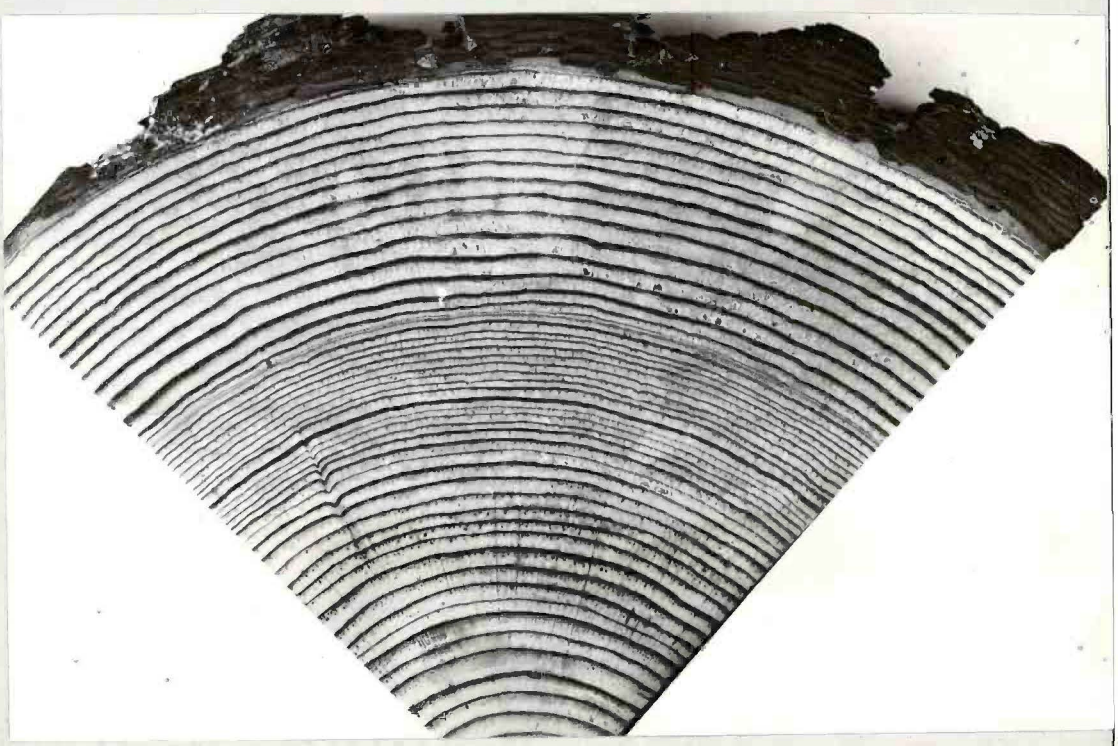


Figure 14



CAMBIUM SCAR ON NORTH EXPOSURE OF TREE 89, PLOT I

Fig. 13 - Section at 5 feet, north exposure. When tree 89 was felled and sectioned, it was found that the cambium had been killed near the base on the north side. The heat had not burned away the outer bark so that this injury was not detected when tree was first examined in July, 1924. The scar was about 5 inches wide. It was found in sections at 5 and 10 feet and was checked up to a total height of about 14 feet.

Fig. 14 - Section at 20 feet, north exposure. At this height there is no evidence of the effect of the cambium scar on the growth behavior.